



## **EVALUATION TEST PROGRAMME FOR CAPACITORS FIXED**

**ESCC Basic Specification No. 2263000**

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## **1 INTRODUCTION**

### **1.1 PURPOSE**

The purpose of this specification is to establish the procedure to be followed in the evaluation of component capabilities as required for space applications and thereby to anticipate, as far as possible, component behaviour during qualification testing. Therefore, the aim of such testing shall be to overstress specific characteristics of the component concerned with a view to the detection of possible failure modes. Additionally, a detailed destructive physical analysis shall be performed to detect any design and construction defects which may affect the lifetime of the component and to facilitate failure analysis activities.

The evaluation shall also include a check of the susceptibility of the component to ESD damage.

### **1.2 SCOPE**

This specification covers fixed capacitors as detailed in the ESCC Generic Specifications listed in Para. 2.2 below.

## **2 APPLICABLE DOCUMENTS**

### **2.1 GENERAL**

The following documents form part of, and shall be read in conjunction with, this specification.

### **2.2 ESCC SPECIFICATIONS**

- No. 3001 Generic Specification for Capacitors, Fixed, Ceramic Dielectric, Types 1 and 2.
- No. 3002 Generic Specification for Capacitors, Fixed, Tantalum, Solid Electrolyte.
- No. 3003 Generic Specification for Capacitors, Fixed, Tantalum, Non-solid Electrolyte.
- No. 3004 Generic Specification for Capacitors, Fixed, Glass Dielectric.
- No. 3005 Generic Specification for Capacitors, Fixed, Aluminium, Solid Dielectric.
- No. 3006 Generic Specification for Capacitors, Fixed, Metallised Plastic Film Dielectric.
- No. 3007 Generic Specification for Capacitors, Fixed, Mica Dielectric.
- No. 3008 Generic Specification for Capacitors, Filter.
- No. 3009 Generic Specification for Capacitors, Fixed, Chips, Ceramic Dielectric, Types 1 and 2.
- No. 3011 Generic Specification for Capacitors, Fixed, Chips, Tantalum, Solid Electrolyte.
- No. 3012 Generic Specification for Capacitors, Leadless, Surface Mounted, Tantalum Solid Electrolyte, Enclosed Anode Connection.
- No. 20400 Internal Visual Inspection.

No. 20500 External Visual Inspection.

No. 20900 Radiographic Inspection.

Unless otherwise stated herein, reference within the text of this specification to "the Basic, Generic or Detail Specification" shall mean the relevant ESCC Basic, Generic or Detail Specification.

### 2.3 OTHER (REFERENCE) DOCUMENTS

ESA PSS-01-702, A Thermal Vacuum Test for the Screening of Space Materials.

IEC Publication No. 68-2, Basic Environmental Testing Procedures.

MIL-STD-750, Test Methods for Semiconductor Devices.

## 3 PROCEDURE

Standard components shall be selected from a homogeneous lot at the Manufacturer(s) to be evaluated. These components shall not have been submitted to any screening or burn-in, but must have been manufactured in conformity with high reliability practice and an established Process Identification Document (PID) or an identifiable process which shall form the basis for a PID, in sufficient quantities to permit a random sample to be chosen for the evaluation test programme from a quantity of 2X to 5X that required.

The tests specified in the programme shall be performed in the sequence shown in Chart 1. All results shall be recorded and failed components submitted to a failure analysis. Probable failure modes and mechanisms shall be determined.

The evaluation test programme shall be performed, under the supervision of the ESCC Executive for whom the evaluation of the component concerned is required, by the Manufacturer or at a test laboratory approved by the ESCC Executive.

## 4 TEST PROGRAMME SEQUENCE AND SAMPLE DISTRIBUTION

### 4.1 GENERAL

The number of components chosen for evaluation testing shall depend upon whether a single component type or a family of parts is evaluated and the number of component types chosen to represent the family.

Not less than 110 specimens shall be used for each test programme.

The component types chosen to represent a family shall cover the range of components to be evaluated and be representative of the different configurations under consideration. They shall also be the most suitable for highlighting those characteristics and parameters that are pertinent to an investigation into failure modes and weaknesses.

The above mentioned quantity shall be submitted to the full evaluation procedure whenever a new technology has been applied to the components concerned, such that there is insufficient experience in their production.



4.2 **DETAIL SPECIFICATION(S)**

Should a Detail Specification(s) for the device(s) to be evaluated not exist, the Manufacturer shall prepare such a document(s) in accordance with the established ESCC format and submit it to the appropriate ESCC Executive for provisional approval. This shall then serve as a basis for the ordering and testing of the relevant components.

4.3 **INSPECTION RIGHTS**

The ESCC Executive reserves the right to inspect at any time the components processed for evaluation purposes. The Manufacturer shall notify the ESCC Executive at least 3 working days in advance of the date of internal visual inspection.

4.4 **CONTROL DURING FABRICATION**

The components shall be procured with reference to an established PID. Internal visual inspections shall be performed on the lot to be tested to the extent that this forms part of the Manufacturer's standard procedures. Progress of the components shall be observed closely and recorded, together with an analysis of any rejects. A chart showing the numbers in/out and failure cause for each fabrication stage shall be submitted to the ESCC Executive.

**5 INSPECTION**

5.1 **GENERAL**

The components shall be checked to verify their suitability for the Evaluation Test Programme. Defects or deviations from the established ESCC requirements may invalidate the evaluation.

5.2 **DIMENSIONS (100%)**

All devices shall be inspected in accordance with Physical Dimensions of the Detail Specification and the results recorded together with any non-conformities. Rejected components shall be replaced.

5.3 **ELECTRICAL MEASUREMENTS (100%)**

These measurements shall be performed in accordance with Room Temperature Electrical Measurements of the Detail Specification at an ambient temperature of  $+22 \pm 3^{\circ}\text{C}$  (go-no-go). Rejected components shall be replaced.

5.4 **EXTERNAL VISUAL INSPECTION**

All devices shall be inspected in accordance with Basic Specification No. 20500, except for Ceramic Chip Capacitors which shall be inspected in accordance with Basic Specification No. 20400. Rejected components shall be replaced.

5.5 **RADIOGRAPHIC INSPECTION**

Unless otherwise stated in the Generic and/or Detail Specification, all devices shall be inspected in accordance with Basic Specification No. 20900. Additional axes to those specified in the ancillary specifications of Basic Specification No. 20900 may be radiographed if, by so doing, it is possible to observe any faults. Rejected components shall be replaced.

5.6 **HERMETICITY**

Unless otherwise stated in the Generic and/or Detail Specifications, fine and gross leak tests shall be performed on all components in accordance with the requirements of the appropriate paragraph in the relevant Generic Specification. Rejected components shall be replaced.

5.7 **PARTICLE IMPACT NOISE DETECTION (PIND) TEST (100%)**

All devices with an internal cavity shall be tested in accordance with MIL-STD-750, Test Method 2052, Test Condition 'B'. Detected particles shall be trapped with a suitable method in order to identify their origin and criticality.

5.8 **MARKING AND SERIALISATION (100%)**

All components shall be marked and serialised in accordance with the standard procedures of the Manufacturer concerned.

5.9 **MATERIALS AND FINISHES**

All non-metallic materials and finishes, that are not within a hermetically sealed enclosure, of the components specified herein shall be tested in accordance with ESA PSS-01-702 to verify its outgassing requirements, unless relevant data is applicable.

5.10 **COMPLETION OF INSPECTION**

The completion of inspection shall result in a batch of components that have been verified as to their suitability for the Evaluation Test Programme, i.e. each component has satisfied the requirements of Paragraphs 5.2 to 5.8 above, inclusive.

**6 INITIAL ELECTRICAL MEASUREMENTS (100% READ AND RECORD)**

These measurements shall be made according to Room Temperature Electrical Measurements of the Detail Specification. All characteristics shall be recorded against serial numbers.

**7 EVALUATION TEST PROGRAMME**

7.1 **GENERAL**

The evaluation tests shall be performed as specified in Chart 1. The components shall be randomly divided into 4 groups and their associated subgroups in the proportions indicated in Chart 1. When a family of components is under investigation, the variations within that family must be represented in each group/subgroup. The Group 2 tests shall be completed and the results analysed before the Group 3 tests are commenced.

7.2 **GROUP 1 - CONTROL GROUP**

This group shall be retained for comparison purposes. Whenever electrical measurements are made on any devices under test, these devices shall also be measured.

7.3 GROUP 2 - DESTRUCTIVE TESTS

7.3.1 General

This group shall be randomly divided into three subgroups in the proportions indicated in Chart 1.

7.3.2 Subgroup 2A - Thermal Shock/Construction Analysis

7.3.2.1 *Thermal Shock*

(a) Equipment

Separate chambers shall be used for the extreme temperature conditions required by steps 1 and 3. The air temperature of the two chambers shall be held at each of the extreme temperatures by means of circulation and sufficient chamber thermal capacity, such that the ambient temperature will reach the specified temperature within two minutes of the specimens being transferred to the appropriate chamber.

(b) Procedure

The specimens shall be placed in the chamber such that the air can flow freely across and around them. They shall be submitted to 25 cycles consisting of steps 1 to 4 as detailed in (c) below. The specimens shall not be subjected to forced circulating air during transfer between chambers. Direct heat conduction to the specimens shall be minimised.

(c) Test Conditions

Step	Temperature (°C)	Exposure Time (min)
1	-65 (+0 -5)	30
2	+25 (+10 -5)	5
3	+125 (+3 -0)	30
4	+25 (+10 -5)	5

(d) Measurements

Electrical measurements shall be performed as follows:

- Initial: In accordance with Table 2 of the Detail Specification
- After 10 cycles: In accordance with Table 4 of the Detail Specification
- After 15 cycles: In accordance with Table 4 of the Detail Specification
- After 25 cycles: In accordance with Table 2 of the Detail Specification

7.3.2.2 *Construction Analysis*

The purpose of this analysis, consisting of a series of examinations and evaluations, is to examine the construction of a device and to assess potential reliability hazards. Each step shall be recorded separately and a summary of the entire process and the results thereof shall be made.

Potting shall be followed by step grinding with a critical examination, in at least 3 planes, of each component. A full description of each type of component shall be made, with photographs to highlight the functional elements. The description shall include, but not be limited to, the component type, method of construction, dielectric material, method of termination and sealing techniques (if applicable).

The critical examination shall explore areas including structural integrity, dielectric consistency, metallisation uniformity, plating material thickness and consistency, plate parallelism, termination adequacy and sealing capability.

Ceramic, chip or leaded, devices (meeting the requirements of Generic Specifications No. 3001 or 3009) shall be analysed in accordance with Basic Specification No. 23400. A photographic record shall be made of any defects or anomalies in the above.

### 7.3.3 Subgroup 2B - Step-stress, Selection of Accelerated Life Conditions

#### 7.3.3.1 *General*

This subgroup shall be randomly divided into two further subgroups in the proportions indicated in Chart 1. The Subgroup 2B(i) tests shall be completed and the results analysed before the Subgroup 2B(ii) tests are commenced. The step-stress sequences shall be terminated when 50% (rounded up) of the specimens have been destroyed, unless practical reasons prevent this.

#### 7.3.3.2 *Subgroup 2B(i) - Voltage Step-stress Test*

The tests in this subgroup shall be performed as specified in Chart 2 at the maximum operating temperature as defined in Maximum Ratings of the Detail Specification. Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification. The starting voltage (which will be no lower than the maximum operating voltage as defined in Maximum Ratings of the Detail Specification) and the voltage steps to be employed will be decided by the ESCC Executive.

#### 7.3.3.3 *Subgroup 2B(ii) - Temperature Step-stress Test*

Before commencing this test the ESCC Executive will review the results from the Voltage Step-stress Test in order to determine a suitable applied voltage for this test. The tests in this subgroup shall be performed as specified in Chart 3. Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification. The starting temperature (which will be no higher than the maximum operating temperature as defined in Maximum Ratings of the Detail Specification) and the temperature steps to be employed will be decided by the ESCC Executive.

#### 7.3.3.4 *Subgroup 2B(iii) - Torque Step-stress Test*

##### (a) *Applicability*

This test is only applicable to devices with a screw termination.

##### (b) *Procedure*

The tests in this subgroup shall be performed as specified in Chart 4. The devices shall be mounted on non-ferrous metal sheet of a thickness sufficient to permit at least 1 1/2 threads to protrude when the nut is fully tightened. Each device shall be surrounded by an area of metal approximately 10X that of the mounting hole. The devices shall have their maximum rated voltage, as defined in Maximum Ratings of the Detail Specification, applied. Rapid Change of Temperature shall be applied in accordance with IEC Publication No. 68-2-14, Test Na. The high temperature shall be +125 (+10 -5)°C and the low temperature shall be -65 (+10 -5)°C with 30 minutes at each temperature extreme. Automatic transfer test equipment with a change-over period of less than 30s is allowed. Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification. The starting torque (which will be no higher than the maximum torque defined in the Detail Specification) and the torque steps to be employed will be decided by the ESCC Executive.

#### 7.3.3.5 *Analysis of Subgroup 2B*

The analysis of Subgroup 2B shall be presented to the ESCC Executive in a graphical form, supported by the actual results, as follows:

- The number of functional failures shall be plotted against each voltage, temperature or torque (if applicable) applied. The cumulative failure rate shall also be plotted.
- The parameters (as defined above) shall be monitored (if applicable), recorded and plotted against time for each voltage, temperature or torque (if applicable) applied, as appropriate.
- The average drift of the parameters at each voltage, temperature or torque (if applicable) applied shall be plotted against voltage, temperature or torque (if applicable) as appropriate.

The analysis of the results of Subgroup 2B(i) shall be used to determine the most effective applied voltage for Subgroup 2B(ii).

The analysis of the results of Subgroup 2B(i, ii and iii (if applicable)) shall be used to determine the most effective applied voltage, torque (if applicable) and temperatures  $T_1$ ,  $T_2$  and  $T_3$  for the steady-state accelerated life test (Group 3).

#### 7.3.3.6 *Failure Analysis (see Charts 2, 3, 4 and 5)*

All failed components shall be analysed. The depth of analysis shall depend upon the circumstances in which failure occurred and upon whether useful information may be gained. As a minimum, the failure mode shall be determined in each case. Components not failing catastrophically, i.e. those displaying out-of-tolerance electrical parameters, shall not be removed from the test sequence but shall be monitored to observe degradation trends.

### 7.3.4 Subgroup 2C - Mechanical Capability Tests

#### 7.3.4.1 *General*

The following tests shall be performed, as applicable, in the order below, on all specimens submitted to this subgroup.

#### 7.3.4.2 *Accelerated Damp Heat*

##### (a) *Applicability*

This test is not applicable to chip capacitors, ceramic or tantalum, which meet the requirements of Generic Specifications No. 3009 or 3011.

##### (b) *Procedure*

IEC Publication No. 68-2-30, Test Db, Severity (b), Variant 2, Number of Cycles 6. Initial and final measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification. Measurements after each cycle shall be made in accordance with Parameter Drift Values of the Detail Specification.

#### 7.3.4.3 *Robustness of Terminations*

##### (a) *Applicability*

As in Para. 7.3.4(a) above.

##### (b) *Procedure*

IEC Publication No. 68-2-21, Test U. The ESCC Executive shall review the component type and technology employed to determine the applicability of the following tests:

- Test Ua1 : 20N for 5 seconds.
- Test Ua2 : 20N for 5 seconds.
- Test Ub : Method 1.

- Test Uc : Method B.
- Test Ud : Severity 1.

Different devices shall be utilised for each applicable test. All devices in the subgroup shall be employed, with not less than two devices submitted to each test.

At the conclusion of each test the devices shall be visually inspected in accordance with Basic Specification No. 20500. Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification.

#### 7.3.4.4 *Vacuum Life*

(a) *Applicability*

This test is only applicable to tantalum, non-solid capacitors, which meet the requirements of Generic Specification No. 3003.

(b) *Procedure*

- The capacitors shall be weighed individually.
- They shall be mounted by their terminals, such that their anodes are facing downwards, in a suitable chamber which will maintain the temperature at +85 (+3 -0)°C.
- Atmospheric pressure shall be reduced to  $1 \times 10^{-6}$  mm Hg (10%).
- DC rated voltage shall be applied gradually (not to exceed 5 minutes) either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes. Voltage shall be applied continuously. The impedance of the voltage source as seen from the terminals of each capacitor shall not exceed 10 ohms. Storage batteries or an electronic power supply, capable of supplying at least 100mA when the capacitor is shorted out shall be used. For non-polarised capacitors, the voltage shall be reversed every  $125 \pm 10$  hours.
- The test duration shall be 500 (+48 -0) hours.
- Within 24 hours of the completion of the test, electrical measurements as specified in Room Temperature Electrical Measurements of the Detail Specification shall be performed.
- Each capacitor shall be weighed and the weight loss shall be expressed as a percentage of the initial weight.

#### 7.3.4.5 *Seal Test*

(a) *Applicability*

As in Para. 5.6 above.

(b) *Procedure*

As in Para. 5.6 above.

#### 7.3.4.6 *Solderability*

(a) *Applicability*

This test is only applicable to chip capacitors, ceramic or tantalum, which meet the requirements of Generic Specifications No. 3009 or 3011.

(b) *Procedure*

The capacitors shall be mounted as follows:

- The solder shall be either preformed or a paste and be silver-bearing (2% eutectic Sn/Pb together with a non-active flux).
- The capacitors shall be placed across the metallised land area of the test substrate in such a manner that contact is made between chip and substrate land area.
- Electrical measurements in accordance with Room Temperature Electrical Measurements of the Detail Specification shall be made.

- The substrate shall be placed in or on a suitable heat transfer unit (hot plate, tunnel oven) of which the temperature is maintained at +215 to +260°C until the solder melts and reflows as a homogeneous solder band, but for no longer than the maximum soldering time as defined in Maximum Ratings of the Detail Specification.

The adhesion of capacitors to the substrate shall be tested as follows:

- A force of 20N shall be applied normal to the line joining the terminations and in a plane parallel to the substrate, for a duration of 10 seconds.
- At the conclusion of the test the components shall be visually inspected in accordance with Basic Specification No. 20400.
- Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification.

#### 7.4 GROUP 3 - STEADY-STATE ACCELERATED LIFE TEST

This group shall be randomly divided into three subgroups in the proportions indicated in Chart 1. The applicable tests shall not be performed until the Group 2 tests have been completed and analysed, and 3 test conditions selected. The tests in this group shall be performed as specified in Chart 5.

The temperature  $T_1$  shall be chosen such that within approximately 1000 hours, the parameter(s) can be expected to have drifted to an extreme of the permitted range.  $T_2$  and  $T_3$  shall be similarly chosen, but the drift durations are 700 hours and 400 hours respectively. A common applied voltage and torque (if applicable) also determined from the Group 2 tests, shall be used.

Intermediate electrical measurements shall be performed in accordance with Room Temperature Electrical Measurements of the Detail Specification at the following times:

$T_1$ (1000 hrs)	$T_2$ (700 hrs)	$T_3$ (400 hrs)
200 ±24 hrs	200 ±24 hrs	200 ±24 hrs
400 ±24 hrs	400 ±24 hrs	400 (+24 -0) hrs
700 ±24 hrs	700 (+24 -0) hrs	-
1000 (+24 -0) hrs	-	-

Failed components shall be removed for analysis as specified in Para. 7.3.3.6.

#### 7.5 GROUP 4 - ESD TESTING

ESD testing shall be performed in accordance with Basic Specification No. 23800. If the component under examination is not categorised into 1 of the 3 classes listed, then the component shall be termed "unclassified". With the agreement of the ESCC Executive the test structure may be used in place of the components.

### 8 DATA DOCUMENTATION

#### 8.1 GENERAL REQUIREMENTS

An evaluation test report shall be established. This shall comprise of the following:



- (a) Cover sheet (or sheets).
- (b) List of equipment (testing and measuring).
- (c) List of test references.
- (d) Sample identification.
- (e) Production data.
- (f) Inspection data.
- (g) Initial electrical measurements.
- (h) Group 1 - Control Group Data.
- (i) Subgroup 2A - Thermal Shock/Construction Analysis Data.
- (j) Subgroup 2B(i) - Voltage Step-stress Test Data.
- (k) Subgroup 2B(ii) - Temperature Step-stress Test Data.
- (l) Subgroup 2B(iii) - Torque Step-stress Test Data (if applicable).
- (m) Subgroup 2C - Mechanical Capability Tests Data.
- (n) Group 3 - Steady-state Accelerated Life Test Data.
- (o) Group 4 - ESD Test Data.
- (p) Summary of results and conclusions.

Items (a) to (p) inclusive shall be grouped, preferably as subpackages, and for identification purposes, each page shall include the following information:

- Manufacturer's/test house's name.
- Lot identification.
- Date of establishment of the document.
- Page number.

## 8.2 COVER SHEET(S)

The cover sheet (or sheets) of the evaluation test report shall include as a minimum:

- (a) Reference to this document, including issue and date.
- (b) Component type and number.
- (c) Lot identification.
- (d) Manufacturer's/test house's name and address.
- (e) Location of the manufacturing plant/test house.
- (f) Signature on behalf of the Manufacturer/test house.
- (g) Total number of pages of the evaluation test report.

## 8.3 LIST OF EQUIPMENT USED

A list of equipment used for tests and measurements shall be included in the evaluation test report. Where applicable, this list shall contain the inventory number, Manufacturer type number, serial number etc. This list shall indicate for which tests such equipment was used.

## 8.4 LIST OF TEST REFERENCES

This list shall include all references or codes which are necessary to correlate the test data provided with the applicable tests.

## 8.5 SAMPLE IDENTIFICATION

This shall identify the criteria used for the selection of the particular components used for the tests, when evaluating a range of components by means of representative samples.



8.6 PRODUCTION DATA

The progress of the components through the normal manufacturing processes shall be documented. The components failing a particular process shall be detailed, together with the reason for their removal.

8.7 INSPECTION DATA

The number of components subjected to each test shall be identified together with the number and reason for any rejects. Radiographs (where applicable) of any failed components shall be presented.

8.8 INITIAL ELECTRICAL MEASUREMENTS

All data shall be recorded against serial numbers. A histogram of device parameters shall be produced.

8.9 GROUP 1 - CONTROL GROUP DATA

All data shall be recorded against serial numbers.

8.10 SUBGROUP 2A - THERMAL SHOCK/CONSTRUCTION ANALYSIS DATA

All data shall be recorded against serial number. This shall include:

- (a) Photographs.
- (b) Description of components.
- (c) Microsectioning photographs.

8.11 SUBGROUP 2B(i) - VOLTAGE STEP-STRESS TEST DATA

All data shall be recorded against serial numbers. This shall include:

- (a) Starting Voltage.
- (b) Voltage steps used.
- (c) Electrical measurements tabulated for each step.

8.12 SUBGROUP 2B(ii) - TEMPERATURE STEP-STRESS TEST DATA

All data shall be recorded against serial numbers. This shall include:

- (a) Applied voltage.
- (b) Starting temperature.
- (c) Temperature steps.
- (d) Electrical measurements tabulated for each step.
- (e) Graphical output as defined in Para. 7.3.3.5.
- (f) Analysis of any failed components as defined in Para. 7.3.3.6.

8.13 SUBGROUP 2B(iii) - TORQUE STEP-STRESS TEST DATA (IF APPLICABLE)

All data shall be recorded against serial numbers. This shall include:

- (a) Starting torque.
- (b) Torque steps.
- (c) Electrical measurements tabulated for each step.
- (d) Graphical output as defined in Para. 7.3.3.5.

- (e) Analysis of any failed components as defined in Para. 7.3.3.6.

8.14 SUBGROUP 2C - MECHANICAL CAPABILITY TESTS DATA

All data, as applicable, shall be recorded against serial numbers. This shall include:

- (a) Accelerated damp heat test results.
- (b) Robustness of terminations test results.
- (c) Vacuum life test results.
- (d) Seal test results.
- (e) Solderability test results.

8.15 GROUP 3 - STEADY-STATE ACCELERATED LIFE TEST DATA

All data shall be recorded against serial numbers. This shall include:

- (a) Applied voltage.
- (b) Applied torque (if applicable).
- (c) Temperatures chosen for each group.
- (d) Electrical measurements tabulated and plotted for each intermediate time as defined in Para. 7.4.
- (e) Drift values referred to the initial electrical measurements (Para. 6).
- (f) Analysis of any failed components as defined in Para. 7.3.3.6.

8.16 GROUP 4 - ESD TEST DATA

All data shall be recorded against serial numbers. This shall include:

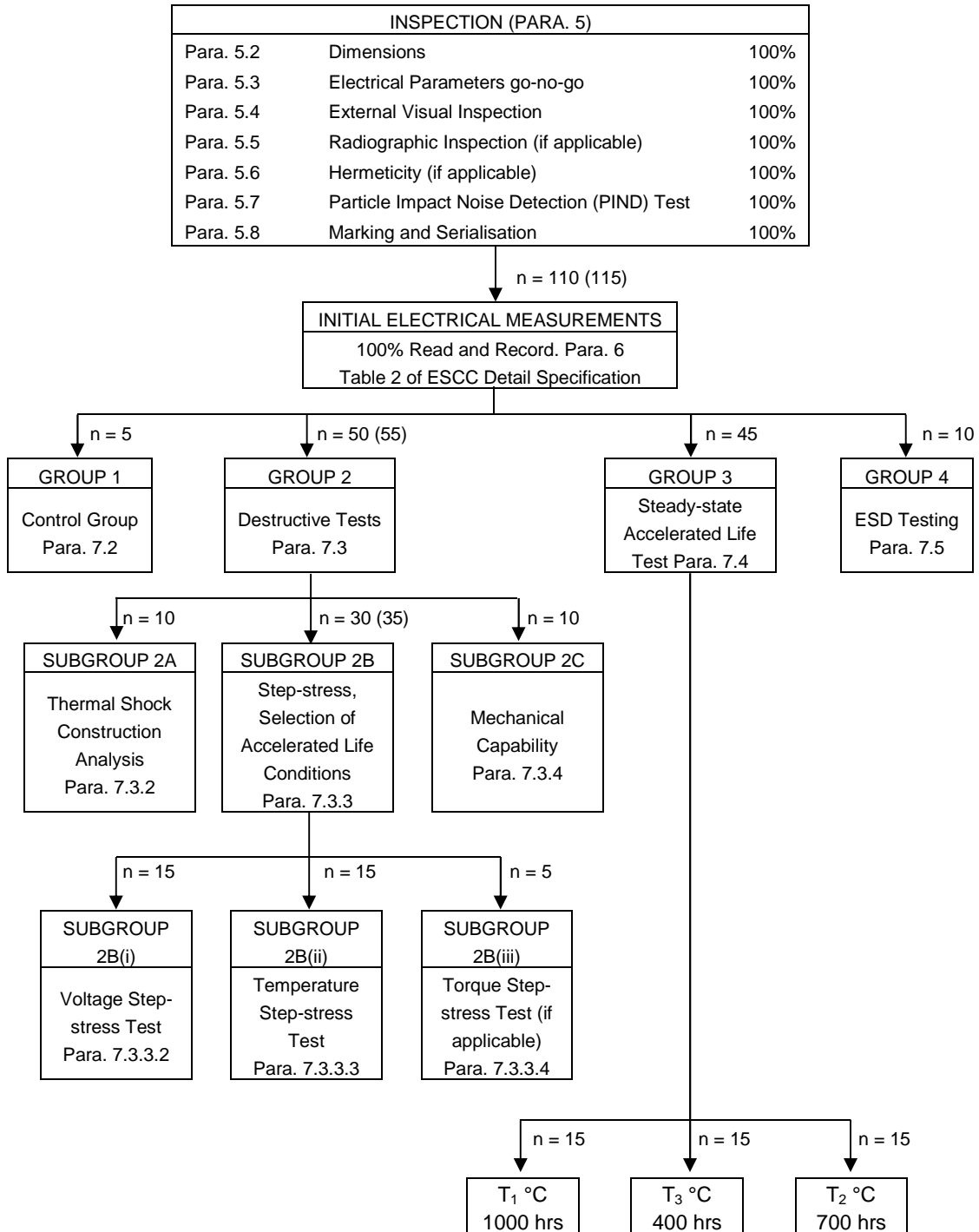
- (a) ESD classification.
- (b) Critical path failure voltage.

8.17 SUMMARY OF RESULTS AND CONCLUSIONS

The above shall be briefly reviewed, indicating the success or otherwise of the Evaluation Test Programme. Any production screens that need to be introduced into the PID shall be outlined.

**9 CHARTS**

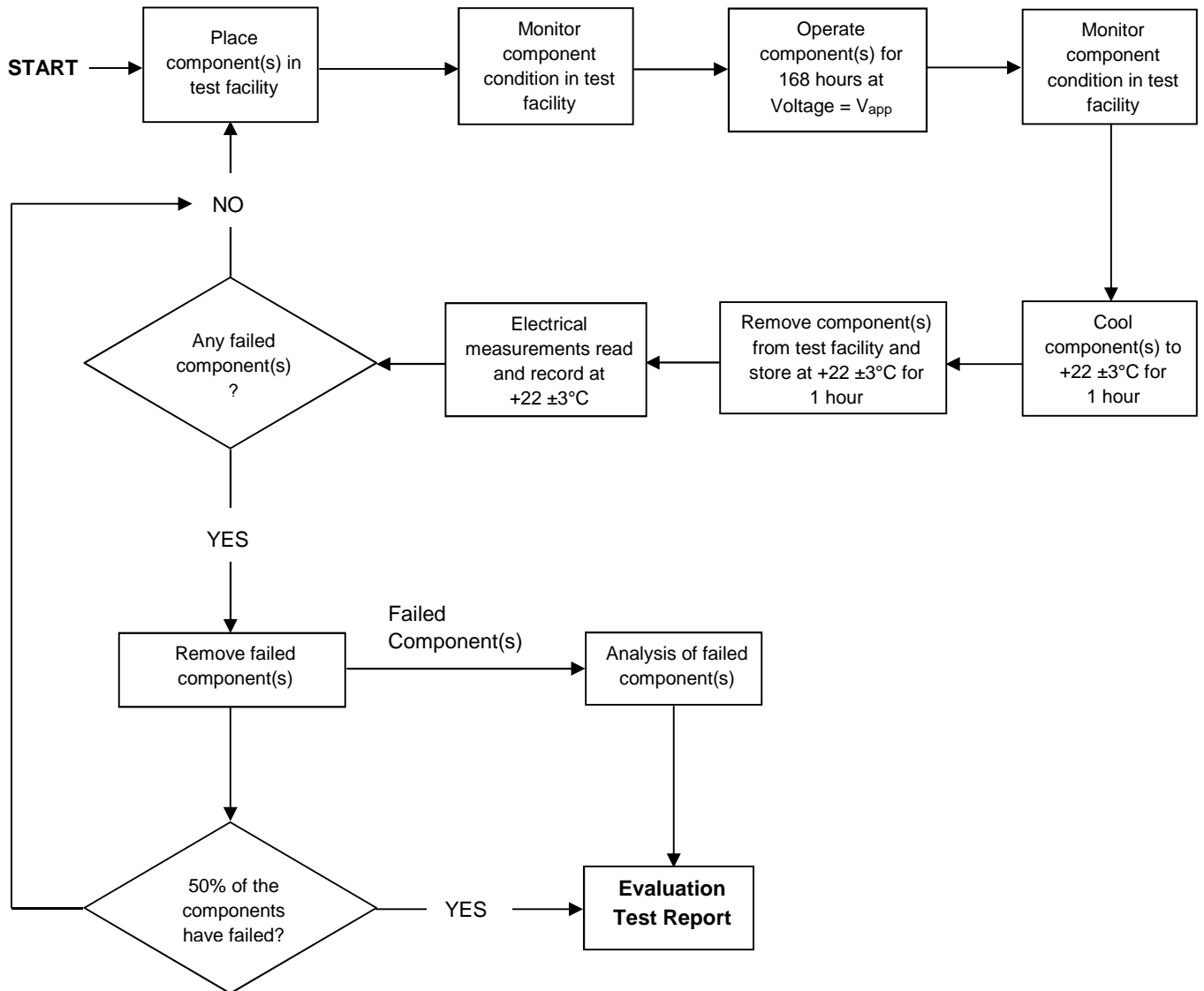
**9.1 CHART 1: EVALUATION TEST PROGRAMME**



**NOTES:**

1. Quantities in brackets apply if subgroup 2B(iii) is performed.

9.2 **CHART 2: VOLTAGE STEP-STRESS SEQUENCE**



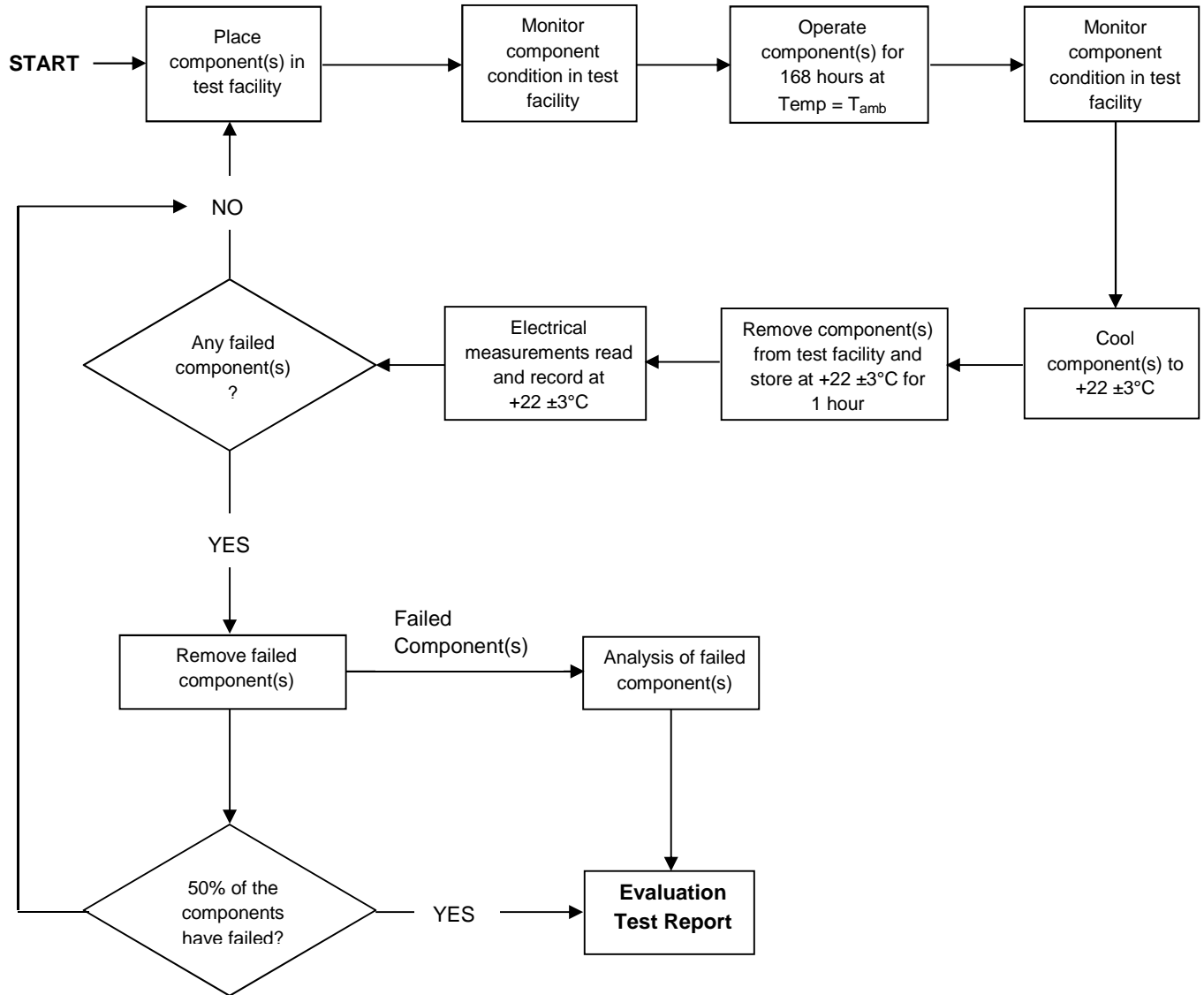
**NOTES:**

Voltage steps with  $V_{app}$ :

First step :	$V_0$	V
	$V_1$	V
	$V_2$	V
Last step :	$V_n$	V

With  $(V_n > \dots V_2 > V_1 > V_0)$

9.3 CHART 3: TEMPERATURE STEP-STRESS SEQUENCE



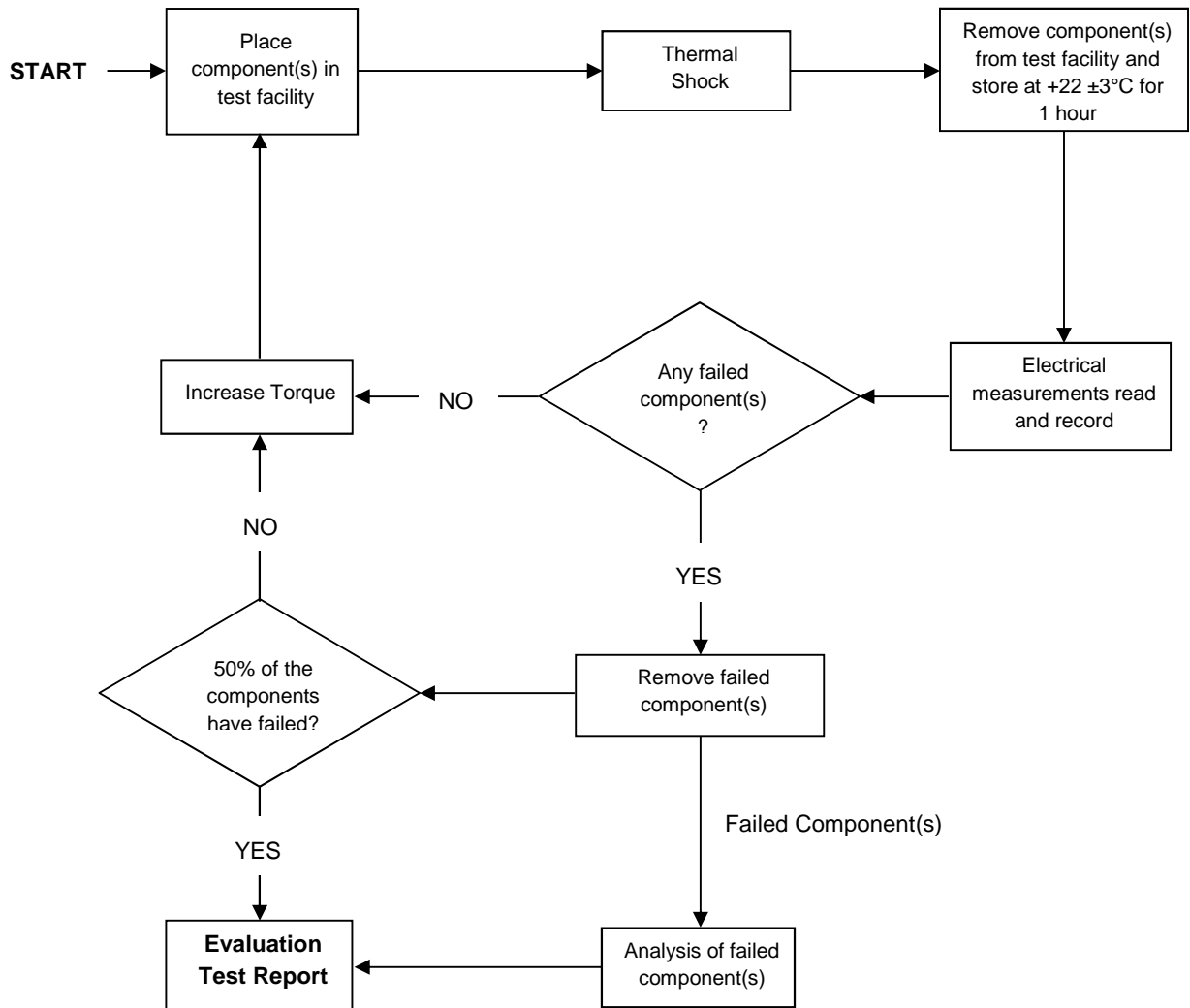
**NOTES:**

Temperature steps with  $T_{amb}$ :

- First step :  $T_0$  °C
- $T_1$  °C
- $T_2$  °C
- Last step :  $T_n$  °C

With  $(T_n > \dots T_2 > T_1 > T_0)$

9.4 CHART 4: TORQUE STEP-STRESS SEQUENCE



9.5 CHART 5: STEADY-STATE ACCELERATED LIFE TEST

